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UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1494

Washington, D. C. ▼ September, 1927

TIMBER GROWING AND LOGGING PRACTICE IN THE WESTERN WHITE PINE AND LARCH-FIR FORESTS OF THE NORTHERN ROCKY MOUNTAINS

MEASURES NECESSARY TO KEEP FOREST LAND PRODUCTIVE AND TO PRODUCE FULL TIMBER CROPS

By

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Introduction by
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INTRODUCTION

Forestry in the United States is no longer merely a theory or a subject for discussion; it has gotten down to concrete things in the woods. Nor is the growing of timber confined to public lands; it is gradually making headway on land in private ownership. It is becoming an art of land management, expressed in practical measures

for protecting forest growth from fire and other destructive agencies, for logging timber so as to produce a new crop of wood, and for planting forest trees on cut-over or denuded areas. The value of timber, along with other economic considerations, is causing landowners more and more widely to study the possibility of profitable reforestation. These developments have created a general demand for information on the timber-growing methods which are adapted to the various types of forest growth in the United States and on what these methods will cost.

Timber culture, like the growing of farm crops, is necessarily governed in any country by the soil and climate, by the requirements of the native forest trees, and by the national economic circumstances. Lessons may be drawn from the experience of other countries, as the United States has drawn upon the forestry practice of Europe, but profitable methods of growing timber, particularly under the wide range of forest types and economic conditions in the United States, can be evolved only from our own experience and investigation, region by region. Hence, to meet the demand for information on practical ways and means of growing timber profitably in the various parts of the United States, it is important that the results of our own experience and investigation to date be brought together and set forth in the clearest possible way.

This the Forest Service has attempted to do in a series of bulletins dealing with the 12 principal forest regions of the United States. The information presented has been gathered from many different sources, including the experience, as far as it was obtainable, of landowners who have engaged in reforestation. An effort has been made to bring together all that any agency has yet learned or demonstrated about the growing of timber in the United States, and the results have been verified as far as possible by consultation with the forest industries, State foresters, and forest schools. These publications thus undertake to set forth in a simple form what are believed to be the soundest methods of reforestation as yet developed in our common experience and study in the United States.

Necessarily, the Forest Service claims no finality for the measures proposed. Timber growing in every country has come about through a gradual evolution in industrial methods and the use of land. All too little is yet known of the best methods of growing timber under American conditions. As time goes on, research and practical experience will add greatly to the success and certainty of the measures carried out in our woods, just as American agriculture has steadily become more highly developed or just as our manufacturing processes have been perfected through experience and study. But we know enough about growing timber now in the forest regions of the United States to go right ahead. Believing that the forest landowners of the United States are now ready to engage in timber growing on a large scale, the Forest Service has endeavored to place before them in concise terms the best suggestions and guides which the experience of this country to date affords.

In these publications the measures proposed for a particular forest region have been arranged in two general groups. The first includes the first steps, or the minimum measures based on local physical conditions, that are needed to prevent timber-bearing land from becom-

ing barren. These measures, in which the prevention of fire is of outstanding importance, represent, broadly speaking, the least that must be done and the lowest cost that must be incurred to keep forest lands reasonably productive. While influenced in some cases by the economic conditions in the region, they have been worked out primarily from the standpoint of the landowner who may not be ready to engage in real timber culture but who wishes to prevent cut-over tracts unsuitable for any purpose except timber growing from becoming a liability on his hands. Except within certain limitations, which are discussed in dealing with particular regions, the Forest Service believes that these first steps or minimum measures should be speedily applied to all of the forest lands in the United States. And the service believes that public policy should encourage their universal application in such ways as protection from fire and the adjustment of forest taxation to the business of timber growing.

The second group of proposed measures constitutes what may be called the desirable forestry practice in the region concerned as far as our knowledge and experience to date enable us to determine it. These measures are designed to grow reasonably complete crops of the more valuable timber trees, making full use of the real productive capacity of the land. The recommendations are addressed primarily to the landowner who wishes to use his property up to its full earning power for timber culture. It is impossible to frame any general set of measures of this character that are adapted to the individual needs of particular holdings or industrial establishments. This is true particularly of forest regions like the Northeastern States, which include a great variety of local situations both in the types of growth and in economic circumstances. Hence, in presenting this group of suggested measures the Forest Service has attempted only to draw the broad outlines of the more general and fundamental things, with illustrative methods of forest practice. The details of intensive forestry, like the details of intensive agriculture or engineering, call for expert survey in working out the plans and methods best adapted to a particular tract of land or a particular business. One of the most important features of expert planning for the management of a particular forest property or for a supply of raw material for a particular forest industry is to devise not simply woods operations that will produce full crops of timber but also a scheme of logging that will afford a continuous yield of products desired, in order that sustained earnings may be realized or a sustained supply of raw material made available.

In some cases it is not practicable to draw a hard-and-fast line between the first steps that will maintain some degree of productiveness on forest land and the more intensive measures that will bring the quantity and quality of wood produced up more nearly to an ideal management. Gradations between the two general groups of measures are inevitable. The Forest Service has not attempted, therefore, to deal with the two general types of forest practice as wholly separate and distinct, but has rather endeavored to present a common-sense and practical résumé of the various steps in timber growing in the form that will be most helpful to the man in the woods. The bulletins have been written for the landowner and the lumberman rather than for the technical forester. Their purpose

is to put the main ideas into the most useful form, considering the special needs and problems of each region, for aiding the man to whom timber growing is a concrete business and logging problem. At the same time it is hoped that they will have a value for the everyday reader who is interested in forestry as an important phase of land use in the United States and in the public policies designed to bring forestry about.

It is impossible for publications necessarily dealing in broad terms with the conditions existing over large regions to attempt any brass-tack conclusions on the cost and returns of timber growing. The approximate cost of the measures advocated is indicated as far as practicable, and the extent to which they may be of benefit in connection with logging operations, but with no attempt to segregate the items chargeable to harvesting one crop of timber from those which should be regarded as invested in a following crop. Conservative estimates of the future yields of timber that may be expected under the various practices recommended are given where the facts available appear to warrant them; but no forecasts of the profits to be derived from commercial reforestation are attempted. The financial aspects of forestry can not be dealt with in general terms. Here again expert advice must deal with the situation and with the problems of the individual forest owner or manufacturer.

As a broad conclusion, however, with the exception of limited situations which are dealt with region by region, the Forest Service has tremendous faith in the commercial promise of timber growing to American landowners. The law of supply and demand is working steadily to create timber values which in large portions of the United States will pay fair returns on forestry as a business. The economic history of other countries which have passed through a cycle of virgin-forest depletion similar to that which the United States is now traversing points to the same inevitable conclusion. The time is fast approaching when forestry, and forestry alone, will supply the enormous quantities of wood demanded by American markets. The fundamental laws of business must in the nature of things so operate as to enable the markets of forest products to be supplied at a profit to the grower of timber. The returns already being obtained from this form of land employment at many points in the eastern United States show plainly enough that this relationship between the value of timber and the cost of producing it is already coming about to a marked degree.

To the men who own forest-producing land in the United States or who are engaged in industries which require timber as raw material, forestry now offers a commercial opportunity. Satisfactory returns from forestry can not be promised in sweeping terms any more than returns from the manufacture of lumber or paper. But the opportunity for a profitable employment of capital and business talent in the growing of timber merits the same consideration and the same expert guidance as industrial opportunities in the conversion of timber. This applies with special force to the commercial institutions in the United States which have made large capital investments in manufacturing plants and distributing organizations, dependent for their maintenance upon a future supply of forest-grown material.

It applies equally to the owners of land, in large tracts or farm wood lots, the earning capacity of which lies solely in the growing of trees and which, without tree growth, will become either a doubtful asset or an outright liability.

The Forest Service earnestly asks the forest landowners of the United States to determine for themselves, with the same care with which they would approach any other business problem, whether timber growing does not offer a commercial opportunity which should be grasped. It commends this series of bulletins to them, not as a complete or authoritative scheme that can forthwith be followed with profit in their own woods, but as a starting point in utilizing the opportunities that forestry may hold out.

THE REGION AND FOREST TYPES

That portion of the inland empire which includes the Idaho "panhandle" north of the Salmon River and the northeast corner of Washington, and extends east in Montana to the Continental Divide, contains five distinct and important forest types. Two of these—the western yellow pine and the lodgepole pine types—although extensive outside this region, are mainly transitional here. A third type, the Engelmann spruce, is confined almost wholly within the boundaries of national forests, where timber growing and logging practice follow definite Forest Service requirements and need no special explanation. The remaining types are those covered in this bulletin—the western white pine type and the western larch-Douglas fir type.

Of the two the western white pine type is the more extensive, covering the Idaho panhandle and the tip of Washington and running in outliers or stringers into northwestern Montana. Interlaced with it are other types, the Engelmann spruce at the upper margins and the larch-fir at the lower.

The larch-fir type is found in lesser degree than the western white pine type throughout the same region. It is usually intermediate between the western white pine and the western yellow pine and blends somewhat with both. Where the larch-fir type occurs within the yellow pine belt it occupies the moister north and east slopes. Within the white pine zone it occurs more often on sites with a southerly aspect, or on upper slopes too dry for the white pine. Its most characteristic occurrence is in northwestern Montana. Here the larch-fir attains its most important development and is distinctly the major type, covering large areas in unbroken forests.

Although the western white pine and larch-fir types are closely identified in extent and frequently merge in individual stands, logging methods and silviculture in the two types differ considerably. Furthermore, in susceptibility to fire, in inflammability of slashings, and in other particulars the differences are marked. For this reason the two types are treated separately in this bulletin. For the most part, and unless otherwise specified, the western white pine type is represented by the forests of northern Idaho, the larch-fir type by the forests of northwestern Montana.

THE WESTERN WHITE PINE TYPE

IMPORTANCE OF WESTERN WHITE PINE

The lumber industry of north Idaho is built largely around the white pine type. In 1923, 42 per cent of the cut north of the Salmon River was western white pine (*Pinus monticola*), 27 per cent was western yellow pine (*P. ponderosa*), and the remaining 31 per cent was principally western larch (*Larix occidentalis*), Douglas fir (*Pseudotsuga taxifolia*), western red cedar (*Thuja plicata*), lowland white fir (*Abies grandis*), and western hemlock (*Tsuga heterophylla*) cut in conjunction with white pine operations. Of the other species cut Engelmann spruce (*Picea engelmanni*) has a slight importance, but northern black cottonwod (*Populus trichocarpa hastata*) and lodgepole pine (*Pinus contorta*) are negligible. Lumbering in the greater part of north Idaho, with the comparatively high logging costs encountered, is made possible only through the high value of the white pine.

In view of the limited distribution of western white pine, figures on the available supply in north Idaho (Table 1) are of particular interest. These estimates, compiled from various sources, are the best obtainable at present.

TABLE 1.—*Timber stand in Idaho north of the Salmon River*

[Millions of board feet — i. e., 000,000 omitted]

Ownership	Western white pine	Western yellow pine	Douglas fir and western larch	Other species	Total
National forest	3,868	1,909	5,953	9,995	21,725
Other Federal	165	149	245	214	773
State	2,255	411	1,687	1,907	6,260
Private	7,246	3,086	6,563	5,699	22,594
Total	13,534	5,555	14,448	17,815	51,352

In addition to the 13,534,000,000 feet of white pine in Idaho, 1,482,000,000 feet is estimated to be in northwestern Montana and 300,000,000 feet in northeastern Washington, making a total of 15,316,000,000 feet in the entire region.

The rate of depletion of the timber in Idaho is a matter deserving serious consideration by the people of the State. Table 2 gives the 1923 cut for north Idaho mills as 883,000,000 feet. In addition to this, approximately 114,000,000 feet was cut in mills located in Washington and drawing all or most of their cut from Idaho, making a total cut from the State north of Salmon River of 997,000,000 feet. Of this quantity 58,000,000 feet was cut from the national forests. The drain on the private and State timber was, therefore, about 939,000,000 feet. When this figure is applied to the estimated total of 29,000,000,000 feet for private and State timber the result would indicate exhaustion of supply in a period of 32 years, assuming that the 1923 rate of cutting is not increased. However, with the proposed construction of new mills in the Clearwater region, there is every reason to expect that the rate of cutting will be increased.

The situation in some parts of the State is even more serious. The cut from the two northern counties in 1923, including the portion sawed in Washington mills, was 204,000,000 feet, of which 29,000,000 feet came from the Kaniksu and Pend Oreille National Forests. Approximately 175,000,000 feet was cut from private lands on which the total stand is estimated at no more than 2,813,000,000 feet. According to this reckoning the privately-owned timber in these counties will last only about 16 years.

TABLE 2.—*Lumber cut for Idaho mills north of Salmon River, 1917–1923* [1]

[Thousand board feet—i. e., 000 omitted]

Species	1917	1918	1920	1921	1922	1923
Western white pine	193,404	208,749	261,251	173,677	297,970	374,381
Western yellow pine	177,918	173,424	229,853	138,317	198,276	234,631
Western larch	98,950	116,691	138,787	70,703	89,627	121,145
Douglas fir	45,086	46,246	72,584	40,914	51,076	67,806
Lowland white fir	36,627	49,644	53,319	22,923	55,828	47,606
Western red cedar	15,319	26,810	26,663	13,872	20,269	25,930
Engelmann spruce	18,770	12,360	9,822	9,666	12,965	9,958
Western hemlock	1,325	204	120	15	50	1,021
Northern black cottonwood	473	261	1,376	916	44	711
Lodgepole pine	146	50	60	8	50	6
Total	588,018	634,439	793,835	471,011	726,155	883,195

[1] Cut for 1919 is omitted, as census was not completed for that year.

The Coeur d'Alene Lake region is also being rapidly cut out. It is estimated that, at the present rate of cutting, the privately owned timber there will last only 20 to 25 years.

It is true that the national forests in Idaho will furnish a permanent supply of timber, for they are managed for continuous production, and each year's cut is limited to the amount of wood grown; but their annual yield is not over 275,000,000 feet, and this will fall far short of meeting the present needs of the region.

It may therefore be expected that within 30 years the cut from Idaho will be greatly curtailed, and that in less than half that time certain portions of the State, where the lumber industry is now of the greatest importance, will be seriously depleted of timber.

Whether this will be a permanent loss to the industry or merely a temporary setback will depend largely on the management of the cut-over lands and their protection from fire. There are now very large areas of 10 to 40 year old second-growth timber throughout north Idaho. Cutting may begin in the older of these stands, if they are saved from fire, in perhaps 30 to 50 years. Also when some years ago a considerable amount of yellow pine and larch-fir timberland in the State was logged, much material was left just under merchantable size, and this now promises to yield a second cut in another 20 or 30 years. The situation is therefore not beyond remedy if, through efficient fire protection, amendment of tax laws, and general encouragement of timber growing, the most is made of the timber-growing resources of the State.

CHARACTER OF THE FORESTS

Western white pine is confined to regions of deep snowfall where there is a comparatively short growing season. Consequently, except

at the extreme lower edge of the type, white pine land even on level ground and in good soil has no great agricultural value. The deep snowfall insures ample moisture, which results in a vigorous and rank forest growth, at times almost resembling the luxuriant Pacific coast forests. Underbrush is usually heavy, and the ground becomes covered with a deep layer of duff from partly decomposed vegetable matter.

The western white pine type comprises an extremely complex mixture of species. The principal associate species are Douglas fir, western larch, lowland white fir, western red cedar, and western hemlock. From an economic standpoint these species are at present a problem both to the forester and the lumberman. For the past five years the spread between the average mill-run prices of white pine lumber and larch and Douglas fir lumber has been about $24. White fir has run about $2 above larch and Douglas fir.

It is obvious that under logging conditions where white pine can be logged at a fair profit, larch, Douglas fir, white fir, and hemlock will show an actual loss. In many cases this loss amounts to from $3 to $7 a thousand. This condition, as will be shown later, has a profound influence on the possibilities of the practice of forestry in the western white pine type.

Most of the white pine type originally came into being as even-aged forests following forest fires. Young stands of this character following fires in 1889 and 1910 occur extensively. At about 70 to 80 years, on average sites, such a stand begins to reach merchantable size. At 120 to 160 years it is at its best and usually attains maximum volume. At some time between 160 and 200 years most stands begin to deteriorate. Decay becomes prevalent, and the loss from bark-beetle attacks may be very great. The white pine drops out more rapidly than most of its associate species and by the time the forest is 300 or 400 years old, or even earlier, has generally disappeared entirely, leaving a residual stand of the shade-enduring species, chiefly hemlock, cedar, and white fir, ordinarily very defective at this age. Overmature stands such as this are common in the national forests, but most privately owned timber is younger.

BASIC FACTS BEARING ON TIMBER GROWING

SEED STORAGE

Western white pine bears a good seed crop about every three or four years. The seeds drop from the cones in the late fall and become buried in the heavy layer of duff which often accumulates to a depth of 5 or 6 inches under the dense cool shade of the virgin forest. It has been well established through observation and experiment that white pine seed thus buried in the duff and well shaded retains its vitality for several years. If the duff layer is not destroyed by fire, the seeds germinate when the timber is cut and a new stand is established.

Reforestation from seed in the duff can be expected in the majority of cases after cutting. It apparently does not always occur, however. Failures are probably due to too long an interval between the cutting and the last seed crop, or perhaps in some instances to an exceptionally dry season following cutting, which, if it does not

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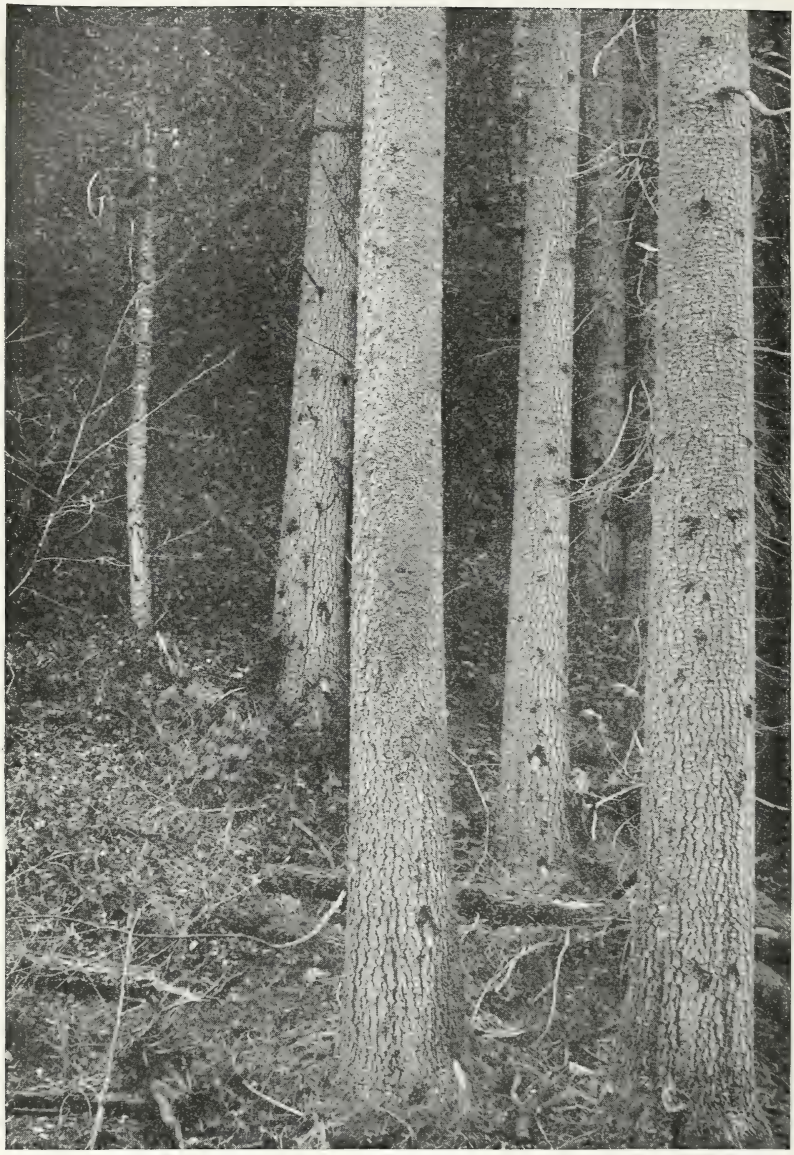
A TYPICAL EVEN-AGED WESTERN WHITE PINE FOREST

This stand in northern Idaho is about 160 years old and ready to yield 50 or 60 thousand board feet to the acre. With clear cutting, careful slash disposal, and subsequent prevention of fire, this forest will be succeeded in 70 to 90 years by a "second-growth" forest of merchantable size



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"A CLOSE-UP" OF A FINE 160-YEAR-OLD WHITE PINE FOREST IN NORTHERN IDAHO

prevent germination, will be likely at least to kill the seedlings in their first season. It is to avoid such failures that in most cuttings in the national forests seed trees are retained.

EFFECT OF FIRE

When a virgin forest of white pine is destroyed by fire a splendid stand of seedlings usually follows. This stand probably originates in part from seed in the duff and in part from seed in cones on the trees which the fire did not reach. The duff under a virgin stand is usually moist and is seldom destroyed entirely by a forest fire.

When a slashing is burned, however, the result is likely to be less favorable. Reproduction after such a fire is by no means assured. In a spring fire the duff may be so moist that it is not consumed, and good reproduction will follow; but if the slash fire occurs in the summer or fall, the duff will have been dried out by the sun and wind and is apt to be entirely consumed along with the seed in it. If burning is delayed for a year or two after cutting, the seed will have already germinated, and all the seedlings will be killed. Any deliberate burning of slash as it lies, then, aside from other dangers, is very likely to result in little or no reproduction of white pine, although occasionally, if conditions are all favorable, excellent stands of young growth will follow, particularly if the burning is done in the spring immediately following logging.

There is still a great deal about the laws of white pine reproduction which foresters do not know, but it can be stated with a considerable degree of assurance that if the duff is not consumed good reproduction usually follows cutting, whereas if the duff is completely consumed there will be little or no reproduction, unless seed trees are present.

EFFECT OF SHADE

White pine seedlings will not germinate and develop under too dense shade. Consequently if too much hemlock, white fir, Douglas fir, and cedar is left from a cutting the reproduction of white pine is hindered or may be entirely prevented. Since larch casts only a light shade and is less likely to have an unfavorable influence on the white pine, it may safely be left in greater quantities. On dry sites a moderate shade is favorable to white pine reproduction. The most favorable shelter will vary from 15 to 25 per cent crown cover on steep south slopes to 5 to 15 per cent on flats and no shade on north slopes.

Under Forest Service practice, it is customary to cut all sound white fir and hemlock over 12 inches in diameter (breast high). Any considerable amount of defective hemlock or white fir is disposed of either by girdling or felling, and lopping and piling the brush. This is an expensive process and may cost up to $20 or $30 per acre but is often the only way in which the productivity of the site can be maintained.

PRESENT LOGGING PRACTICE AND ITS RESULTS

Most white pine logging employs horse skidding, chutes, and railroad or river-drive transportation. Power logging is used in only two or three operations in the white pine region.

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Utilization of white pine is very close. Practically all trees 10 inches and over breast high are cut and logs are taken down to a 5 or 6 inch top diameter. The utilization of other species is very far from complete because of their comparatively low value at present. Many operators are taking out only the white pine and the cedar poles and leaving all or practically all of the other species in the woods. Utilization of other species varies greatly with different operators, but there is no doubt that under average white pine logging conditions and with a normal market Douglas fir, larch, white fir, and hemlock are handled either at a loss or on a very small margin of profit.

Private lands logged over for white pine have generally been burned over shortly after cutting, either intentionally in the spring and fall to comply with the State slash disposal law or accidentally during the fire season. The large amount of mixed species and the many defective trees or trees below merchantable size left uncut are prey to the first slash fire, which kills much of this material. In a few years these dead trees begin to fall, and often create a worse fire hazard than the original slash. As a result most cut-over white pine land burns a second and probably a third and fourth time. The tangle of dead and down trees, the snags still standing, the undergrowth of thistle, dry grass, and fireweed altogether form so combustible a combination that it is almost impossible to protect it from fire or to stop a fire that has started in it.

As a result the cut-over white pine lands in Idaho are as a rule in very bad shape for timber growing. Whole townships are almost completely denuded, and such reproduction as has become established is in constant danger of being destroyed by fire. Probably over 75 per cent of the cut-over land in the white pine type in north Idaho is in a nonproductive condition as a result of fire. In this respect the white pine cut-over lands in the region are in very much worse condition than the yellow pine and larch-fir types.

MEASURES ESSENTIAL FOR GROWING TIMBER

FIRE CONTROL

Protection against fire, although it will not by itself insure full productivity of forest land, is the one essential measure for growing timber in the western white pine type. In this type the fire danger becomes critical nearly every summer, a condition for which dry winds and low summer rainfall are largely responsible. In north Idaho the annual rainfall averages over 30 inches, but the July and August rainfall is only about 2 inches. In this particular there is a resemblance to Pacific coast conditions and a decided contrast with those in eastern Montana. In eastern Montana the average annual rainfall is less than 16 inches, but the July-August total ranges from 2.4 to 2.9 inches, and danger from fire is correspondingly less.

The heavy annual precipitation in north Idaho gives rise to luxuriant forests containing much cedar, hemlock, and fir understory and accumulating much dead and down material. In the summer these forests are dried out to the point of high inflammability by the lack

of moisture and the hot, dry winds blowing from the dry region east of the Cascades. The fire danger is greatly increased by the fact that these winds blowing against the sunny slopes reach their greatest velocity during the hottest part of the day. In the Clearwater region, where the summer winds blow parallel with the ridges and canyons, their drying, carrying, and fanning effect is still greater.

The fire history of north Idaho forests is marked by a number of "peak years" in which unfavorable climatic conditions united to threaten widespread disaster. The seasons of 1889, 1910, 1914, and 1919 stand out in particular. In addition, even the more favorable years have one or more brief but highly dangerous waves of extreme dryness. These critical periods can be forecast at present with only fair accuracy and then for only a short time in advance.

To meet such conditions, a protective organization is demanded which must be not only efficient but thoroughly elastic—easily and quickly expansible to meet any emergency.

CUT-OVER LAND PROTECTION

A great difference in fire danger between uncut timber stands and cut-over areas is generally recognized. Any cutting increases the fire danger for a number of years, the period varying with the method of slash disposal.

The annual fire season is much longer on the cut-over areas than in green timber. In green timber danger does not become critical until after considerable drought and high temperature, usually some time in July; but cut-over lands respond abruptly to changing weather conditions and not infrequently have serious fires in early May and even in April. The situation in the fall is similar. Rains early in September usually put an end to the danger of fire in green timber, while on cut-over or burned areas fires may continue to run several weeks longer. The probable duration of the season on cut-over areas is roughly twice that in green timber.

A quantitative comparison of inflammability is, of course, out of the question. One indication of the relation, however, is the statement of one of the timber-protective associations that in a five-year period 60 per cent of the burned area was on cut-over land, which constituted only about 10 per cent of the area protected. The records of another association for a five-year period indicate that only about 3 per cent of the class C fires (those over 10 acres) started in green timber and that they covered only about 1 per cent of the total acreage burned. It is evident, therefore, that to be equally effective action on fires on cut-over land or in old burns must be more prompt and more forceful than that required to protect green timber.

As a rule, cut-over land is more exposed to special risk than is green timber. It is traversed by railroads or adjoins agricultural clearings; it is crossed by highways and is frequented by picnickers or berry pickers. Important also is the fact that the interest of the public in the protection of cut-over land has not reached a point where every fire is recognized as a matter of public concern. All in all the need of law enforcement and educational work is infinitely more urgent for cut-over land than for merchantable timber.

In these three particulars, then—the duration of patrol and protective effort, the intensity of protection, and the need of law enforcement and education—the requirements of the cut-over areas are much more exacting than the reasonably simple requirements of the green timber.

This applies, of course, primarily to the cut-over lands of to-day, those which have been broadcast burned and left in a half-devastated condition. Whenever after a considerable period of adequate protection forest conditions are restored, and when in new cuttings slash-disposal methods have been so adjusted as to leave a cover of green timber on the ground, conditions will be much less critical and the difference between cut-over and green timber will be less pronounced.

CAUSES OF FIRES

The causes of fires, as is indicated in Table 3, vary considerably in different parts of the region. Man-caused fires are a big problem in all of the association[1] districts.

TABLE 3.—*Average number of fires annually from various causes, by association districts, 1919–1923*

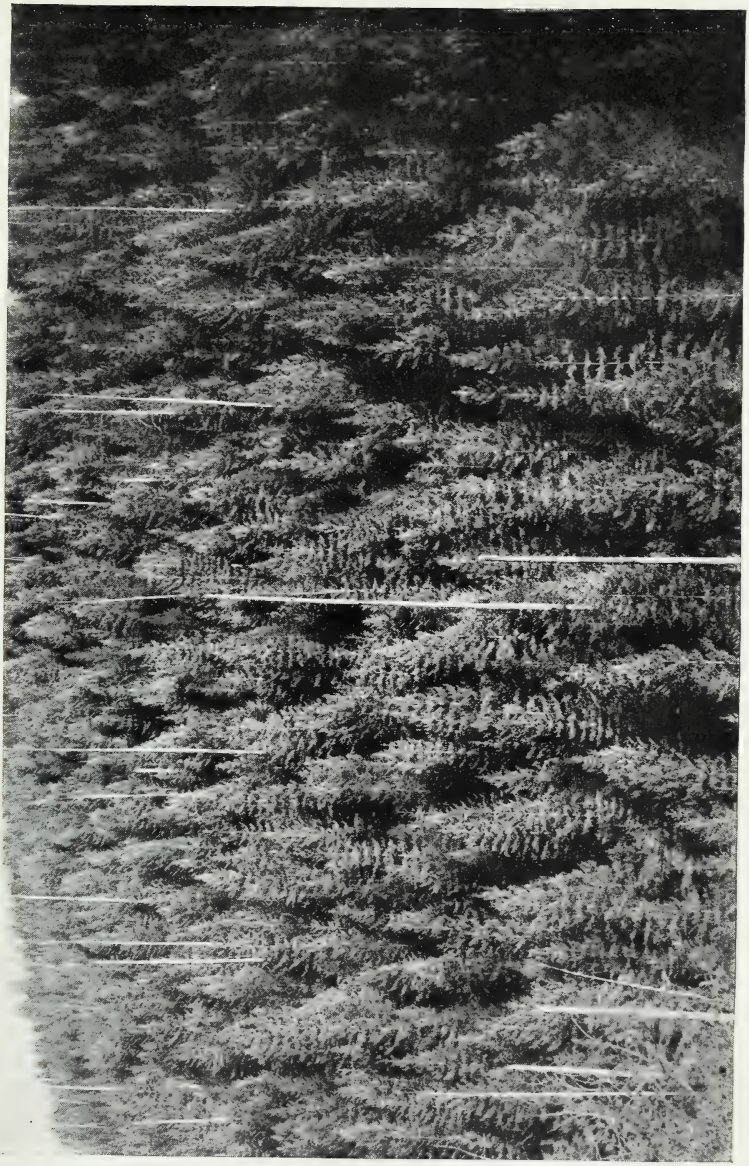
Association districts	Lightning fires	Lumbering fires	Campers' and smokers' fires	Brush-burning fires	Railroad fires	Incendiary fires	Miscellaneous and unknown fires	Percentage of man-caused fires
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*P. ct.*
Clearwater	42	0	3	4	0	2	19	40
Potlatch	53	5	13	3	0	4	12	41
Coeur d'Alene	33	22	8	2	5	1	16	62
Pend Oreille	8	12	11	11	18	4	31	92
Priest Lake	10	1	6	1	0	0	1	47
Total and average	146	40	41	21	23	11	79	60

PROTECTION REQUIRED

The standards of effective fire control are arbitrary and must be so because of scarcity of data on the subject. To meet the demands of continuous timber production, the following standard is set up, namely, that the area burned over each year shall not exceed 0.25 per cent of the area protected. This standard recognizes that a 25 per cent loss during a hundred-year rotation may be unavoidable and will not too seriously impair the timber crop but that a greater loss is inimical to timber production.

It is not the purpose of this bulletin to attempt to outline standard control methods, nor to advance specific plans. Whatever system of protection will hold the burned area to 0.25 per cent yearly for an indefinite period will be reasonably satisfactory. Such a system will, doubtless, be a matter of evolution and will constantly undergo changes with changing conditions. At the same time it may help in arriving at an understanding of objectives to describe the steps which

[1] Practically the entire area of State-owned and privately owned forest land within the white pine region a certain amount of Federal land is included within forest-protective districts which are patrolled and managed by timber-protective associations. Private, State, and Federal resources are thus pooled under one management to provide protection for these units.



F-173264

THE IDEAL TO BE SOUGHT IN CUTTING WESTERN WHITE PINE

This reproduction coming in after a forest fire will, if protected, result in a fully stocked even-aged stand containing a high percentage of white pine

F-157637-597596

CAUSE AND EFFECT OF FIRES IN WHITE PINE SLASHINGS

The great volume of slash left after cutting in the western white pine type (A) makes protection practically an impossibility. A very large percentage of cut-over lands in Idaho have been burned and reburned (B) until only artificial planting will restore the forest

in the light of present knowledge appear to be sufficient to attain this end. The following requirements are therefore suggested, with full realization that they may be inadequate in certain cases, and that in others they may be in excess of needs.

Administration.—(1) On every area there must be some agency responsible for seeing that immediate action is taken on every fire, that each is confined to the smallest possible area, and that no fire is left before it is out.

(2) The responsible agency must be permanent and dependable. Especially it must be assured of constant financial support for a long period. There is little to be gained by protecting forest land for a short while and then abandoning it to fire.

(3) There should be some responsible officer prepared to take suitable action upon every infringement of fire law, to the end that the number of man-caused fires may be greatly reduced. Damages and costs of man-caused fires, especially when resulting from negligence, should be recovered whenever possible from the person or agency responsible—this as much in the interest of equity as to discourage carelessness.

(4) Education in fire prevention must be systematically undertaken. Care of camp fires, matches, and cigarettes must become instinctive with users of the forests. People of the Western States must come to recognize the enormous aggregate damage done by fires that spread on cut-over lands. They must come to appreciate the value of young growth. When the public fully grasps the importance of these matters this realization will doubtless be a tremendous factor in eliminating lack of care in the use of fire. The schools and colleges in the white pine region have an unusual opportunity to serve the States in this respect.

Field organization and plans.—(1) Duration of patrol: The period during which fire patrol should be maintained is affected by many factors, important among which are character of the season, altitude, special risks, whether virgin timber or cut-over land, and (if logged land) the quantity of débris on the ground and the amount of shade from remaining trees.

As a rough guide the following dates may be set up as the period during which the field organization should properly be ready to function:

In green timber	July 1 to September 10
On cut-over land or old burns	May 1 to September 30

For cut-over land handled in accordance with the recommendations of this bulletin the period would be somewhere between these two.

(2) Fire detection: One lookout to every 50,000 acres is necessary. The most intensive lookout system employed by private agencies at present has one lookout for every 27,000 acres. The average is about one to every 55,000 acres. The aim should be, as nearly as possible, to bring 100 per cent of the area under the constant supervision of a permanent lookout never more than 12 miles distant. Observation from two or more points is greatly to be desired.

(3) Patrol and smoke-chaser force: One man to every 10,000 acres is necessary. A standard of three-hour control for green tim-

ber and one-hour control for cut-over land has been recommended by foresters who have studied the situation.[2]

Because of extreme inflammability in the white pine region, the plan is being followed more and more of so stationing men that two or more can go to a fire at the start. Although this results in a slower theoretical hour control, it makes possible more effective action upon arrival.

In 1925 three of the five large protective associations in north Idaho employed patrolmen or smoke chasers at the rate of one for every 10,000 acres; one association employed one for every 12,000 acres; and the fifth, one for every 14,000 acres. Each force had to be augmented during the worst part of the season. One man to every 10,000 acres, as recommended here, has now been accepted as a working standard by these agencies.

(4) Secondary defense: Because of the very critical peak periods characteristic of the white pine region in July and August it has proved very advantageous to have at hand a number of organized small crews from which can be recruited extra smoke chasers, crew foremen, cooks, etc., or which can be used as fire-fighting units. As a less satisfactory substitute in more thickly settled districts arrangements have been made with loggers and millmen for the use of their crews in emergencies.

The very considerable success attending the use of small organized crews employed directly by the protective agencies makes it desirable that more of them may be available in the future. It is to be hoped that improvement projects, for which there is a need, and slash disposal (piling of brush), which is in prospect as a result of the Idaho State law of 1925, will give occasion for permanent employment of additional crews of this sort which will thus be available to the protective agencies in greater number than at present.

Special problems.—Protection against fire in logging operations is one of the most urgent and important problems in forest protection at the present time. Some years the losses are enormous.

The causes of fires most to be looked for in the operations are sparks or coals from steam equipment, hang-over fires from spring brush disposal, smoking by employees or others, neglected lunch fires or fires built to heat chute grease or to smoke out yellow jackets; also blasting, lightning, and incendiarism.

To prevent such fires an excellent set of rules has been issued by the Western Forestry and Conservation Association. With slight modifications to fit this specific region (as suggested in parentheses), they are given below:

> 1. Some one should be responsible for fire prevention over the entire operation and give his whole time to this—a "camp warden."
>
> 2. Every camp should be organized for fire prevention and suppression. Different parts of big operations should be connected by telephone with each other and the outside. Some one at each "side" (logging unit) should be appointed subforeman to direct fire fighting pending the arrival of the camp warden or the foreman. (A whistle code should be worked out to summon men from the woods.)

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[2] Three-hour control may be defined as an organization so placed and equipped that at least one man will be able to reach any possible fire within three hours after its discovery.

3. Instructions should be given to employees handling jobs where special risk is involved. Engineers should have instruction in the care of spark arresters, dumping hot ashes, and sanding flues in dangerous places. Those doing blasting should look out for possible fires.

4. (Smoking during the fire-danger season should be strictly prohibited in the woods.)

5. Patrolmen should follow trains. Usually there should be a speeder patrol on 5 miles or more of road. The speeder should not follow too soon after the train (about 20 minutes). Speeder patrolmen should carry tools (shovel, ax, and grub hoe), also a small water tank and hand pump.

6. Spark-emitting machinery should be provided with safe and suitable devices for arresting sparks.

7. (A device to prevent the escape of fire or live coals from ash pans or fire boxes on locomotives is essential. The Forest Service regards the complete elimination of the wood or coal burning boiler as the only satisfactory ultimate solution of risk from donkeys and locomotives.)

8. Fire-fighting tools should go with each locomotive and logging engine (or group of logging engines) whether oil burners or not. These tools should be kept in a box to be opened only in case of fire. Tools should consist of an assortment of shovels, axes, hazel hose, mattocks, buckets, and hand pumps.

9. Each locomotive and logging engine (or group of engines) should have a power pump ready for use and at least 250 feet of fire hose.

10. Storage of water at logging-engine settings in reservoirs, tanks, or barrels is necessary, unless there is a gravity system to which the pump can be connected.

11. In operations using railroads there should be some sort of fire engine or apparatus for pumping water in quantity to fires anywhere within 1,000 feet or so of the railroad tracks. A large gasoline track car with water tank, gas pump, and hose is excellent. (A tank car of not less than 4,000 gallons capacity, either with gas pump or used with steam force pump on the locomotive which moves it, is used on railroad operations on national forest land.)

12. Disposal of slashings. (Rights of way and donkey settings should be completely cleared before the beginning of the fire season. In right-of-way clearing sound green trees 4 inches or more in diameter need not be cut, but should be trimmed up as far as a man can reach with an ax. Brush and small reproduction should be cut close to the ground. All rotten wood, débris, and windfall should be piled and burned. The right of way should be cleared and kept clean of dead grass and weeds and other inflammable material.)

13. Fall dead trees, or snags, within a radius of 100 to 150 feet of the setting of all steam logging engines.

14. Fall snags within 100 feet of the center line of the railway.

15. Clean up and dispose of the inflammable débris around camp in advance of putting up the buildings.

16. Clean débris from about the base of trestles and bridges and supply barrels of water with fire buckets or set sprinkler systems on such structures.

A few other suggestions should be added for the white pine region.

17. Heating of coffee in the woods should not be permitted except at specially prepared camp grounds.

18. Heating of chute grease should be allowed only in special stoves around which all slash and débris has been removed for a distance of 25 feet. Buckets and a supply of water should be available. (Some operators believe that heating of chute grease is

unnecessary, that it can be thinned with a little kerosene, and that in the heat of the day it needs no thinning.)

19. Where water is available at least one portable pump and 1,000 feet of hose should be provided during the fire season for every operation employing 20 or more men.

20. There should be one patrolman for each active camp of 20 or more men, except where two camps are sufficiently close together to enable one man to cover the entire operation once during each half day. He should see that there is no smoking in the woods and that fires for heating chute grease are properly cared for, and should check up on felling areas at noon and night.

21. One or more caches of fire-fighting tools should be available on every operation where men are at work during the fire season. A cache should be large enough to outfit at least 50 per cent of the crew. Tools should be kept in a convenient place ready for use for fire only.

22. All steam rigs should be watched at noon and for an hour after quitting time. With each donkey or loader burning wood or coal one man should be kept to watch for sparks throughout the day during the critical part of the season.

23. Any slash created during the fire season within 100 feet of any highway or any railroad burning coal or wood, or within 100 feet of buildings, donkey engines in operation, lumber piles, construction camps, logging camps, sawmill sites, rollways of logs and tourist camp grounds, or within 25 feet of the center line of any foot or horse trail or railroad using oil-burning locomotives should be piled immediately—that is, concurrently with the cutting of the timber or other forest products—and should be made ready for burning at the first safe opportunity. This is a requirement of the Idaho State law.

24. Every sawmill or other plant manufacturing wood products in or near forest land which burns refuse wood material near forest land should inclose with a fireproof wall at least 12 feet high an area at least 2 feet greater in diameter than the longest sticks which will be burned; or, better still, should provide a regular screen-covered burner.

25. A portable force pump should be kept at each sawmill cutting 20,000 feet or more daily.

The camp warden.—The camp warden proposal has a great many things to recommend it in this region. The principal duties of such a man can be briefly listed:

He will (1) arrange for obtaining and placing in commission all fire tools, water barrels, tank cars, sprinkler systems, telephones, pumps, hose, etc., prior to the opening of the fire season; (2) frequently inspect spark arresters and ash pans and supervise the work of patrolmen and watchmen; (3) post camp rules and State fire laws and enforce them; (4) supervise the piling of slash and later the burning; (5) have well-thought-out plans for fighting any fire that might start throughout the works; (6) observe weather conditions, relative humidity, temperature, and wind to determine the periods of extreme fire danger; (7) put on extra patrols and require additional precautions against starting fires; (8) watch or prohibit entrance to the operation or adjoining cut-over lands of berry pickers, hunters, fishermen, and others.

PRESENT ORGANIZATION

Intermingled ownership on the one hand and the public benefit from fire protection extending beyond the individual landowner's

F-157660-192402

PROTECTING WHITE PINE LAND FROM FIRE IS WELL REPAID

If a cut-over white pine area can be saved from fire, white pine usually predominates in the natural reproduction that follows. On this land (A) where for 15 years after cutting no fire has spread, a good stand of young white pine is coming in. (B) illustrates the care taken along a logging railroad to prevent fire losses, by keeping the right-of-way carefully cleared

F-157624-157627-157606

A GRAPHIC STORY OF BROADCAST BURNING IN THE WESTERN WHITE PINE TYPE

(A) shows the condition shortly after the broadcast burn; all standing timber has been killed, and the ground is covered with a heavy growth of fireweed, grass, and thistle which in August will become very inflammable. (B) is the same area a few years later; dead trees are beginning to fall, and the inflammability is, if possible, greater than that of the original slash, as is also the difficulty of fire control. (C) reveals the common outcome of the condition shown in (B); the area has been burned over several times until with complete destruction of the forest there is no hope of obtaining natural reproduction of forest trees; and withal, inflammability is greater than in green timber

interest on the other have led to the development of cooperative patrol agencies. The timber protective associations which have been in existence some 20 years and which are supported by private, State, and Federal funds, have accomplished much which could not have been done by individual effort. Clearly the mutuality of interest in the problem of fire protection calls for concerted action of public and private agencies.

Provisions of Idaho forest law.—The forestry law [3] passed by the State of Idaho in 1925 contemplates cooperative action of private, State, and Federal agencies, its avowed purpose being "to facilitate the cooperation, financial and otherwise, of the State of Idaho with the other principal agencies with which it is associated in the protection of forest resources, forest range, water conservation * * *."

A cooperative board is provided on which is represented the State administration, including the State university forest school, the timber interests, and livestock interests. A member from the Federal Forest Service serves without vote.

A State forester is provided and is given rather broad powers in the administration of the law and regulations made by the board.

The forest lands of the State are divided into districts, and wardens are provided for each. These wardens are paid by the landowners within the respective districts.

Piling and burning of all logging slash is now required, except where some other method of disposal is approved by the State forester.

Precautions, many of which have been mentioned, are required to be taken to prevent fires in logging operations, along railroads, around sawmills, etc. When proper steps have been taken to dispose of logging slash, a written "clearance" is given to the operator.

Anyone responsible for the starting or existence of a fire on his land is expected to make a reasonable effort to put it out.

The State pays its pro rata share for the protection of State-owned land in each of the districts.

A permit from a fire warden is required to use fire for clearing or similar purpose during the closed season (June 1 to September 30).

Suitable penalties are provided for negligent or malicious use of fire.

Every owner of forest land is required to provide adequate fire protection. He may protect the land himself or may contribute to an association for this purpose.

In the administration of the last-mentioned feature of the law the organized protective associations are recognized and are reimbursed for the cost of protecting noncontributing lands within their boundaries. This cost is recovered from the owner at the time he pays his taxes. Until this law went into effect these agencies, which were organized upon a purely voluntary basis, were protecting about a 50 per cent greater area than was actually paying for protection. Starting in 1906, the Idaho associations by 1909 had a membership representing 1,456,000 acres of contributing forest land. By 1915 the

[3] Idaho. Laws, statutes, etc. General laws of the State of Idaho, passed at the eighteenth session of the State legislature. H. B. 57, pp. 265–286. 1925.

high-water mark of 1,910,000 acres was reached. The membership being voluntary, it was to be expected that with the cutting off of timber there would be a falling off in the number of members and a corresponding contraction of the area protected. This was evident in a shrinkage of the contributing acreage to 1,664,000 by 1924.

Accomplishments.—A glance over some of the past work of the associations will give an idea of how accomplishments lined up with the standards proposed.

A five-year average (1922–1926) of the five principal north Idaho associations shows the following acreages burned over:

	Acres per year
Timbered	4,848
Cut on burned-over areas	33,671

To meet the standard of 0.25 per cent the acreage burned annually should be reduced to a total of about 6,700 acres of the 2,682,000 acres protected.[4]

Fire wardens who are paid directly by landowners in their districts have found it embarrassing to enforce laws applicable to lumbermen and difficult to prosecute farmers on account of the local feeling that they are in the employ of the big lumber interests. The regulation of slash disposal and all brush burning contemplated by the new law accentuates this difficulty. On the whole, law enforcement has proved to be a problem with which associations have been unable to cope successfully.

IMPROVED ORGANIZATION PROPOSED

Sufficent time has not elapsed to give any adequate measure of the results to be obtained under the new law. A strong effort to increase the efficiency of the protection organization is called for in order to cut down the damage, particularly to cut-over lands. That increased efforts in prevention will result in lower costs of fire fighting is also to be hoped. Every effort to cut down the number of man-caused fires should be made. The possibilities of education, research, and law enforcement should be studied and the best means brought to bear to solve this problem.

To put law enforcement upon a workable basis two things seem desirable. The first is a more direct control of this activity by the State; that is, the direct employment of chief wardens, inspectors, and law-enforcement specialists by the State itself. The second thing needed is a method or policy which by holding individuals or agencies accountable for results would serve as a substitute for undue regulation. For instance, if railroads are held responsible for fires started by their engines it will not be necessary to inspect their spark arresters so often; if logging operators are held accountable for any fires starting on land for which they have no clearance, it will not be necessary to have some one constantly on the job to see that the slash is piled; and ranchers will not be so willing to take a chance with brush-burning fires if they know that they will have to pay for any fire getting beyond control.

[4] During the four years 1923–1926 the Potlatch Association, by greatly strengthening its patrol organization, kept the burned area to less than 0.25 per cent of the area protected.

COSTS

It is essential in a study of the timber-growing possibilities of the region to draw a sharp line between the cost of preventing and controlling fires in active logging operations and the blanket cost of protecting forest land.

If the cost of the special patrol necessary during the life of the operation and the cost of suppressing fires caused by the operation or rendered unmanageable because of slash on the ground are included in the blanket cost of protection—that is, are spread evenly over the entire acreage protected—some very erroneous conclusions are likely to be drawn.

In the first place, the actual money cost of improper slash disposal is not brought home to the men in charge of the woods operation. This leads to a practice of gambling with the slash menace in an attempt to get cheaper logs. If this cost is frankly recognized as a logging cost, the expense of proper slash disposal appears in a much better light. On the other hand, the swollen protection costs give a wrong idea of the cost of holding or growing timber and are responsible in no small degree for the doubt which exists in many quarters of the feasibility of growing white pine.

In considering past costs another fact deserves attention. The acreage protected by the associations has been some 50 per cent greater than the acreage contributing. In other words, the total cost has been spread over only two-thirds of the acreage. It is clear, therefore, that the past costs of the Idaho associations is not a fair criterion by which to judge the cost of growing future forests.

The cost of adequate patrol (exclusive of fire suppression) can be fairly closely estimated. Plans drawn up by three associations indicate a cost of about 6.5 cents an acre for patrol. The experience of the Forest Service for the past five years would indicate that 4 cents an acre should be enough to allow for fire suppression. Over a long period of years, during which as a result of improved methods of slash disposal the general fire danger should be expected to decrease, it would seem that 10 cents an acre should be a generous estimate of the cost of protecting the forest land.

Federal aid under the terms of the Clarke-McNary Act of 1924 reduces the cost to the landowner at present about 1 cent an acre. It is contemplated that under this law the Federal Government will eventually bear about one-fourth of the total cost of production, which will bring the net cost to the owner down to about 7.5 cents. Since in practice the Federal funds are being concentrated as far as possible on cut-over land and areas of young growth, the cost for such lands may be still further reduced.

It may be expected that increased expenditure by the States will first take the form of investments in more thorough supervision and inspection as well as a more direct control of key men in the protective organization, and that it will not be reflected to any great extent in the patrol cost except in so far as the general efficiency of the protection work is increased.

No consideration is given in this discussion to the cost of the special precautions needed around logging operations. Beyond doubt the cost will be less in operations where slash is carefully piled and burned than where it has been burned by the broadcast method

or has been allowed to accumulate for a year or two. This difference, if it could be calculated, would be an offset to the cost of piling slash.

Forest Service costs are also open to some objection as a basis for calculating costs on privately owned timberland, since many of the basic conditions are different from those on association areas. However, since 1919 the Forest Service objectives have been similar to those here proposed, and the results shown in Table 4 will be in some measure indicative of what the expenses under the proposed plan may be.

TABLE 4.—*Unit costs of fire control, and area burned; north Idaho national forests, 1920–1924*

National forest	Average annual cost per acre			Average area burned annually
	Patrol [1]	Suppression	Total	
	Cents	*Cents*	*Cents*	*Per cent*
Kaniksu	4.14	7.28	11.42	0.53
Pend Oreille	3.43	3.60	7.03	.23
Coeur d'Alene	5.43	2.99	8.42	.32
St. Joe	6.45	4.79	11.24	.54
Clearwater	4.89	2.53	7.42	.35
Average	4.86	3.93	8.79	.38

[1] Including maintenance of improvements.

SLASH DISPOSAL

No factor in the fire problem of the white pine region is more important than the slash created by logging operations. A white pine slashing, particularly if there is a considerable amount of cedar in mixture, is nearly the most inflammable mass conceivable, short of an actual explosive. If this is burned as it lies, a method ordinarily called "broadcast burning," the inflammability of the area is reduced for one year. But after the first year inflammability increases rapidly because of the large quantity of material killed by the fire, consisting both of young growth and of unmerchantable trees left by the logging operation. The dead trees soon come down in a tangled mass, and fireweed, thistle, and grass grow in the burned soil and become tinder-dry in August.

Most of the slash from logging operations on private land in north Idaho has been burned broadcast, sometimes accidentally but usually intentionally, in an attempt to comply with the State fire law. Most fire wardens and foresters are now in agreement that broadcast burning is not a solution of the problem of disposing of slash. It is almost impossible to protect extensive burned areas, and as a result the same areas burn again. As some one has well expressed it, the old slash burns are the giant powder and the new slash the detonator to set it off. The last few years have seen a long series of such explosions.

In the Coeur d'Alene district in Idaho during a five-year period over 90 per cent of the area burned over by forest fires outside of the Coeur d'Alene National Forest has been swept by fire starting in slashings or in cut-over areas where slash has been disposed of by broadcast burning.

F-178964-176966

EFFICIENT SLASH PILING AND THE RESULT

Slash efficiently piled (A) can safely be burned without scorching live trees or destroying to any considerable extent the débris or duff of the forest floor and the pine seed it contains. After the burn (B) inflammability is reduced to normal. The two views are taken on national forest cuttings; an ample supply of seed-bearing trees of pine, cedar, and larch have been left to supplement the seed in the duff; when the new growth from seed is well established, these seed trees will make possible a profitable intermediate cutting

F-157665-187021

A—A good chance for a second cut in 30 years, since it has been possible to pile the slash so that it can be burned without damaging the young white pine and cedar trees left from cutting

B—The most difficult and expensive condition facing the timberland owner—heavy slash and many defective hemlocks to be disposed of. Such an area may cost $40 to $50 an acre before it can produce a good crop of pine

As a result of the condition in which cut-over lands are left, the dangerous fire period in north Idaho is over twice as long in the operating districts as in the nonoperating. Some years, when no extensive fires occur in the nonoperating districts, there are numerous destructive fires on cut-over areas.

In short, logging operations in the Coeur d'Alene and Pend Oreille districts, the most active logging center in north Idaho, have brought about a condition in which certain areas of cut-over land have burned three or four times in the past few years, and in which the whole cut-over area is being burned over at the average rate of once in 17.5 years in the Coeur d'Alene district and once in 26 years in the Pend Oreille district.

Under such conditions it is obvious that the first and fundamental necessity in growing timber in the white pine region is some form of slash disposal that will leave the land in such shape as to make protection from fire possible.

PILING AND BURNING SLASH

The disposal of slash by piling and burning has been common practice in the national forests for many years. This method consists of complete lopping of the limbs from the top, piling in compact piles, and subsequent burning in the fall or spring. In some instances the slash is burned progressively by building fires and throwing the limbs on, thus making one operation of piling and burning. Either method properly executed results in a clean burn of the slash, with little or no destruction of remaining live trees or young growth, and the burning of not to exceed 10 to 30 per cent of the surface area. Forest conditions on the area are not destroyed. Green trees are left green, and the typical moisture-loving, vegetative ground cover of the forest is not replaced by inflammable fireweed, grass, and thistle, as after a broadcast burn. The duff cover on the ground is not consumed except where the piles are burned, which is an important factor in obtaining white pine reproduction.

Very careful burning of piled brush is essential to keep the fire from scorching living trees or running over the ground between piles. A considerable degree of skill and judgment is required in selecting the proper time for burning. Conditions must be such that the piles are dry enough to burn, but that the ground surface is too damp for fire to run. Such conditions are sometimes found in the fall after the September rains, but early spring is usually the most favorable season.

An area is not rendered fireproof by piling and burning the slash. No white pine area is fireproof. But it is made far safer than either the original slashing or a broadcast-burned area, and the inflammability decreases progressively each year after cutting, whereas on a broadcast-burned area it increases each year for many years after burning.

The present law in Idaho requires all slash to be piled and burned unless some other form of disposal is specifically authorized by the State forester. It is to be expected that under the provisions of the new law piling and burning will become the standard practice and the menace of the broadcast-burned area will gradually disappear.

COST OF PILING AND BURNING

The cost of piling and burning slash in the white pine type under Forest Service standards will usually range between $0.60 and $1.25 per thousand feet, based on 1923 and 1924 wage scales. The cost is affected greatly by the amount of undergrowth, especially hemlock and white fir thickets, which are cut in making skid roads and must be handled along with the slash from the timber. The percentage of defect in the timber is also an important factor. If timber is 30 per cent defective, it is obvious that 30 per cent more slash than the log scale would indicate must be handled. A fair average cost for piling and burning in the white pine type would be $0.90 per thousand.

The information on slash-disposal costs is based chiefly on the cost after the logging has been completed as done on Forest Service cuttings. If the job of slash disposal is taken over by the logger and a serious effort is made to coordinate it with the other logging operations, a very considerable saving in cost seems possible. For example, the very heavy slash produced in cutting rights of way for roads and chutes, instead of being thrown to one side and later rehandled, can often be burned at the time in the middle of the right of way, with an appreciable saving in cost. There are also possibilities in having the swampers do a good deal of the piling, and in some cases the slash can be burned by the swampers before skidding.

The cost of slash disposal should be considered as a logging cost for removing fire danger threatening adjoining lands, standing timber, young growth, logging improvements, and other values. It should not properly be figured as an investment in reforestation of the particular piece of land on which the work is done. For example, the Priest River unit of the Kaniksu National Forest will produce a sustained annual yield of 26,000,000 feet a year. The slash disposal on this cut will amount to about $26,000 a year. This should be considered not as an investment of $20 to $30 an acre on the area cut over each year but rather as an annual charge of 11 cents an acre for protection against the 240,000 acres of productive timberland within the unit.

An added logging cost of $0.60 to $1.25 per thousand for slash disposal is an item of sufficient importance to need some justification. Part of this expense may be considered as an investment in the timber crops of the future. There is reason to believe, however, that a large part if not all of the cost of proper slash disposal in the white pine type can be recovered in reduced fire-fighting costs and smaller losses in standing timber, logs, camps, and other improvements.

Several instances could be cited where forest fires resulting largely from hazardous slash conditions have cost individual lumber companies enough to have paid several times the cost of piling and burning all the slash from their operation. Fires are not infrequent in white pine logging operations, and they destroy camps, flumes, railroad trestles, and logs, valued at many thousand dollars, besides entailing the cost of fire fighting and the loss from disorganization of the operations. Such fires are usually the direct result of undisposed-of slash. On the other hand, there is no record of any serious

loss in logs or in camps and other logging improvements in operations in Forest Service or State cuttings where the slash has been currently piled and burned.

In one well-known white pine operation in northern Idaho a series of bad fires from 1919 to 1924 destroyed nine logging camps and many other logging improvements. Much valuable white pine timber and many cedar poles were burned, the cedar poles being a complete loss and the white pine not more than half salvaged. Altogether the direct loss in improvements, logs, standing timber, and fire-fighting costs has been not less than $1,250,000 to $1,500,000, in addition to a very considerable indirect loss in the disorganized operation and the forced salvage of large quantities of timber regardless of market and labor conditions. The total cut from this operation has amounted to about 300,000,000 feet. At the rate of $1 a thousand feet, the slash resulting from this cut could have been piled and burned currently for $300,000. If piling and burning had been followed consistently from the beginning of the operation there is every reason to believe that there would have been no serious fire losses. The disastrous fires which have occurred developed their intense heat and impetus both in unburned slash and on areas previously broadcast burned but very inflammable.

No figures for the region as a whole show how much of the annual fire loss and costs would be prevented by a general plan of piling and burning; that is to say, how much is due to slash fires or fires occurring in broadcast-burned areas. Any operator, however, could figure it out roughly for his own operations. It seems probable that piling and burning in the white pine type would largely pay for itself in the long run, without taking into account its value in timber growing. This is particularly true where large and growing slashings are continually threatening with destruction extensive stands of valuable white pine near by.

NECESSITY FOR COMPLETE DISPOSAL

The question should be considered whether the cost of piling and burning all the slash might not be reduced by some modification of the method. In the yellow pine and larch-fir types it has been proposed, as a measure which will give a reasonable degree of protection, to pile and burn only a portion of the slash along roads, railroads, chutes, and other lines of hazard, leaving the rest of the slash untouched, and to supplement this with an extra degree of patrol for a few years.

The significant fact is, however, that the western white pine type attains probably the greatest degree of inflammability of any forest type in the United States. Protection measures which would be adequate in the other types will not serve the purpose here. Evidence is conclusive that to make sure of a reasonable degree of protection all slash resulting from logging operations should be piled and burned as a minimum requirement. Further, to insure satisfactory results by this means piling should follow as shortly after skidding as possible, and burning of piled brush should be completed the first fall or spring after piling.

METHODS OF CUTTING

As stated in the preceding pages, protection from fire is the one all-important essential in the western white pine type in reestablishing a new crop after cutting and so keeping forest land productive. With complete fire protection, which includes careful burning of the slash in piles, it may be safely predicted that 60 to 75 per cent of the area cut over will reproduce to a satisfactory stand containing a good percentage of white pine without any necessity for seed trees or other silvicultural measures.

In other words, present logging practice plus complete protection of cut-over areas from fire will permit satisfactory reproduction of desirable species on about three-quarters of the area cut over. Failure to get this is ordinarily to be explained in one of three ways. It may be due to failure of the seed in the duff, which possibly lay too long before cutting, or was impaired by a severe drought following cutting. It may be due to unfavorable site. Or the fault may lie in too much shade, a condition that often results when no other species than white pine is cut or when too many defective, unmerchantable white fir and hemlock are left.

Results from present logging practice can be bettered in varying degree by forestry measures designed to increase yields and to approach correspondingly the production of full timber crops. Just how far it will pay a timber owner to go in modifying logging practice to improve natural results which he will get practically without special effort or expense beyond fire protection will depend on his individual circumstances and the conditions on his land.

In the course of about 20 years' experience in cutting timber in this type the Forest Service has developed methods of handling white pine on the national forests which have in general been successful in leaving the cut-over areas productive and in assuring reproduction of the more valuable species.

SEED TREES

Since the greater part of the western white pine type occurs in practically even-aged stands the usual object of the forester is to cut the existing crop clean and grow his next crop from seed rather than to make a partial, selective cutting with the expectation of a second intermediate cut from the younger and smaller trees. Excellent reproduction from seed already present in the duff may be expected. Since this can not always be depended upon, however, it is desirable to leave seed trees to furnish a continuing supply of seed after cutting. From two to six white pine trees per acre, and the same number of trees of other species, preferably larch or cedar, should be selected and reserved. These should be dominant trees, free from defect, and with good crowns. If the area is accessible it may be possible to cut these trees 10 or 15 years later, after reproduction is well established; otherwise they can be left till the new crop has matured.

In very overmature stands there are often no suitable trees to leave for seed bearers, and in such cases the area must be cut clean. If reproduction does not result from seed in the duff, planting will be necessary to establish a new crop.

TREATMENT OF SPECIES OTHER THAN WHITE PINE

Unfortunately, western white pine rarely occurs in pure stands, and Douglas fir, larch, cedar, hemlock, or white fir are usually associated with it. These species, while essentially useful woods, now have a much lower lumber value than white pine, and it is often questionable whether it pays to log them. Under average white pine logging conditions the margin of profit on these species is very small and cost records often show an actual loss of $3 to $7 a thousand board feet, even when all logging improvements are charged against the white pine. It is only on the easier logging chances or during temporary periods of favorable market conditions that there is any profit in the so-called "mixed" species.

Under the practice followed until recently of broadcast-burning the slash, any timber left standing was irretrievably lost, and this has undoubtedly influenced many operators to try to get out what they could at the time the white pine was logged, even though the returns were small or doubtful.

Assuming that under the present Idaho State law slash will be piled and burned and injury to standing trees will thus be avoided, it will be possible to leave the mixed species for a later cut, if this appears likely to pay better than removing them now. There is every reason to believe that Douglas fir, larch, hemlock, and white fir will increase in value, and there may be a very good profit in holding these species. The State of Idaho is now following this practice in sales of State timber. Except under the most favorable conditions, it would appear that the timber owner would be better off to cut the white pine and the cedar poles and leave all other material standing.

Unfortunately, there is a conflict here between good economics and good forestry. In order to assure satisfactory conditions for white pine reproduction the shade of the virgin forest must to a large extent be removed. If all of the mixed species are left standing, white pine reproduction may be limited, or if the shade is sufficiently heavy may be entirely prevented. The degree of this unfavorable condition will, of course, depend on the amount of timber left and to a considerable extent on the species. Hemlock and white fir cast a heavy shade, and if present in considerable quantities may be fatal to white pine reproduction. Larch casts a much lighter shade and can more safely be left.

In logging operations on the national forests the cutting of all merchantable white fir and hemlock to a breast-high diameter of 12 inches is usually required. This is done on the theory that the Government can afford to take some loss now by removing the inferior species in order to increase the future yield and percentage of the more valuable species. This may not be true in the case of the private timber owner, and if species other than white pine can not now be handled with a reasonable profit it would ordinarily pay to leave them for a possible increase in value, recognizing that there will be some loss in the productive capacity of the land and that the percentage of white pine in future crops will be reduced.

TREATMENT OF DEFECTIVE HEMLOCK AND WHITE FIR

In overmature forests it frequently happens that all or nearly all of the hemlock and white fir in mixture with white pine is defective and unmerchantable, and if left uncut will shade the ground completely and preclude all possibility of obtaining white pine reproduction. Such conditions are more frequent on the national forests than on the general run of private holdings.

The only way to produce a new timber crop on such an area is to dispose of the defective timber. The usual practice will be a combination of girdling and felling, together with piling and burning of brush. This ordinarily involves felling all the small low-crowned trees up to a diameter of 10 to 14 inches and girdling the larger trees. If there are more than 12 large trees to the acre to be disposed of, those in excess should ordinarily be felled and the brush piled and burned, since the girdling of too many trees would create an excessive fire hazard. On southerly slopes and dry flats, however, where some degree of shade is desirable, up to 20 or 30 trees an acre may be left. Trees close to roads or trails should not be girdled because of the fire risk.

The cost of girdling is about 5 cents a tree. The cost of felling and piling and burning the slash is about $1.80 per thousand feet gross scale of the defective timber. The whole operation of cleaning up defective white fir and hemlock may range from a negligible amount to $30 an acre.

If the quantity of defective hemlock is extremely large it may in some cases be preferable to fell all standing trees after logging is completed and broadcast burn the slash. This procedure may necessitate planting to reestablish a stand.

In timber operations in the national forests defective hemlock is commonly disposed of by one of the above-described methods. The practice involves a large expenditure per acre, but, in view of the fact that areas containing heavy stands of hemlock are usually the most highly productive white pine sites, it is desirable, from the point of view of public policy, to reestablish a timber crop, even though only a small rate of return on the investment can be shown.

It is doubtful whether for the average private owner the cost of disposing of defective hemlock and white fir could be justified by the returns. The most extreme defective-hemlock conditions are not found as frequently on private as on public holdings, and those portions on which heavy stands of defective timber are left after logging do not usually offer a promising field for timber growing. Under most circumstances it would not be advisable for the private owner to try to do much with such areas.

SELECTIVE CUTTING IN UNEVEN-AGED STANDS

Although the western white pine type is typically even-aged, there are in some localities considerable areas where the stand is uneven-aged or, more commonly, two-aged. This condition has usually resulted from a light fire at some time running through the stand and killing part of the trees, so that a younger age class has come in under the surviving trees. Under such conditions there is an opportunity to harvest the older timber now and leave the basis

for a second cut later, in perhaps 25 to 40 years. There is very little profit in handling white pine under 12 or 14 inches in diameter, and trees of this class should be left for further growth. Frequently in stands of this sort there are a good many small cedar poles which will yield good returns if left to develop into 35-foot poles.

THINNING IMMATURE STANDS

Opportunities for thinning young stands are limited by the slight demand for small-sized material. However, on accessible areas along railroads or roads, particularly in farmers' wood lots, where there is a market for pulp wood, it may be possible to take out white fir and hemlock which occur in mixture with white pine and so stimulate the growth of the remaining pine.

PLANTING

Many areas have been burned and reburned until there is no prospect of their reproducing naturally for many years. The only method of restoring such areas to productivity is by planting with nursery stock.

The Forest Service has for many years been planting such devastated areas in Idaho and western Montana with western white pine at the rate of 2,000 to 3,000 acres a year. Two or three year old nursery plants are generally used. The cost, including cost of the stock, averages about $10 an acre. The plants are usually spaced about 8 by 8 feet—about 680 plants to the acre. Planting may be done either in the spring or late fall.

CONTROL OF DISEASES AND INSECTS

WHITE PINE BLISTER RUST

The white pine blister rust now exists on white pine in Canada less than 100 miles north of the Idaho line. Just what effect it will have on the possibilities of growing western white pine in the United States it is difficult to predict. It seems inevitable that the disease will sooner or later appear in Idaho, though its progress may be greatly delayed by the practical elimination of the culivated black currant, through which it spreads most rapidly.

It has been demonstrated in New England that white pine can be successfully grown in a region infested with blister rust through eradication of currants and gooseberries, the alternate hosts of the disease. Preliminary experiments in north Idaho have indicated that wild currants and gooseberries can be cleared from white pine land for about $1 to $1.50 an acre. This will doubtless have to be considered as one of the costs of growing white pine.

INSECTS

The principal insect enemy of white pine is the mountain pine beetle, *Dendroctonus monticolae*. This bark beetle has caused very extensive losses of white pine in the past. Incipient attacks can be controlled by felling trees and peeling the bark. While this beetle may do considerable damage in virgin timber, it is believed that

before new crops of pine can be grown management will be sufficiently intensive to prevent any serious losses from this source.

PRACTICABILITY OF GROWING WHITE PINE TIMBER

There is in north Idaho and western Montana at the present time a vast amount of second-growth young timber in individual and company ownership. A large proportion of it is in yellow pine or larch and Douglas fir. A smaller portion includes a fair percentage of the more valuable white pine and cedar. Part of this young growth has followed past forest fires; some of it has come in on cut-over land following logging operations. The more recently cut-over land has been much more severely burned and carries less young growth than most of the older cuttings.

This young growth covers in the aggregate a very large area, which if reasonable protection from fire is given will in time bear merchantable timber and become valuable. Probably the first steps in timber growing in this region will be the recognition of the potential value of reproduction already established and its protection from fire until it becomes of merchantable size. A good many lumber companies own considerable tracts of young growth acquired more or less incidentally with timberlands. A good deal came in after the great 1889 forest fires and is now about 35 years old. On many of the better sites in the western white pine type this will begin to attain merchantable size in about 25 to 35 years. It will then have a definite value which can be seen and measured. In 50 to 60 years it should be worth several hundred dollars an acre. Even with present tax rates and fire-protection costs the holding and protection of this class of forest property seems to offer sufficiently definite and tangible returns to make it a reasonable business proposition.

Second-growth eastern white pine has proved an unexpected bonanza to many New England farmers. Although the rate of growth of white pine in Idaho is probably somewhat lower than that of white pine in the East, there is no doubt that north Idaho farmers who own tracts of second-growth pine and cedar have a valuable asset which should be looked after. In many instances it will doubtless be possible to derive some preliminary revenue from such tracts by thinning out white fir and hemlock for pulp wood to the benefit of the remaining white pine and cedar.

Another step in timber growing that is easily taken is the holding and protection of low-value species left after logging white pine. Under present practice many operators are leaving all or nearly all of the white fir, hemlock, larch, and Douglas fir, for it does not now pay to take it out except under favorable logging conditions. Much of this class of material has been burned up in slash fires. The stand thus left, however, frequently amounts to 10,000 to 20,000 feet to the acre, and no one doubts that these species will increase in value as timber becomes scarcer. Assuming that the slash from the white pine cut has been carefully disposed of by piling and burning, so that protection from fire is possible, there is an excellent chance for a good return in holding these low-value species for an increase.

Many uneven-aged white pine stands contain a considerable number of small white pine trees 8 to 12 inches in diameter, not now merchantable, and often large numbers of small cedar poles. Such

stands afford an excellent opportunity for a second profitable cut in 20 to 40 years. There is little or no stumpage value in a 25 or 30 foot cedar pole, while a 35-foot pole is worth $0.75 to $1. A cedar tree should grow from a 25-foot to a 35-foot pole in about 25 years.

These instances have been cited as examples of the possibilities of reasonably quick returns from timber growing. Growing a new crop from the seed after an average mature stand has been cut takes a matter of 70 to 100 years, and the returns can not be certainly predicted. However, if cut-over land can be left in a productive condition with a new crop started, it certainly will have a greater value than completely burned and denuded land, and if such results can be attained without too great an expenditure the advantages are obvious, whether the owner expects to hold the land himself or to dispose of it. The value of young growth is not generally recognized now, but the experience of all older countries indicates that as timber grows scarcer young growth will have a value.

GROWTH AND YIELD

The timber owner planning to reforest his land or to hold young growth for development is primarily interested in knowing how long he will have to wait for a merchantable crop and what yield he may expect at various ages of the stand.

A preliminary normal yield table has been prepared by the Northern Rocky Mountain Forest Experiment Station, based on measurements of 57 sample plots (Table 5), classified according to three sites representing the general range of soil and growth conditions in northern Idaho. The yields given are based on the Scribner Decimal C rule and include only trees 10 inches and over in breast-high diameter and logs 6 inches and over in diameter.

TABLE 5.—*Normal yield table for the western white pine in northern Idaho; volume in board feet per acre for three sites by Scribner Decimal C rule*

[Based on preliminary studies]

Age	Site I	Site II	Site III
Years	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
40	4,750	4,000	3,250
60	22,800	15,300	8,500
80	41,100	30,000	19,500
100	58,100	42,300	26,500
120	68,400	49,500	30,500
140	75,200	54,100	33,000

It will be noted that on Site II the timber begins to reach merchantable size at 60 years, with a yield of 15,300 feet to the acre. At this stage the trees are growing rapidly, and many of the smaller trees are coming to merchantable size, so that the yield approximately doubles between 60 and 80 years, which would indicate that in most cases it would not pay to cut a stand as early as 60 years. The mean annual growth culminates at about 110 years, which would theoretically indicate the age at which the greatest volume in board feet per year would be produced.

The yields given in the table are for approximately fully stocked stands. It is to be expected that yields over considerable areas would

be somewhat less owing to openings and partially stocked areas in the natural stands. However, yields nearly comparable to those given in the table have been obtained on considerable areas on national forest cuttings where the logs have been actually scaled. For example, the entire drainage of Scott Creek on the Coeur d'Alene National Forest yielded practically 40,000 feet to the acre at the age of 100 years. An area of 150 acres in the Little North Fork of the Coeur d'Alene at 140 years cut 51,000 feet to the acre, with a stumpage return of $340 an acre. This is representative of a considerable area in that vicinity.

It is believed that on the general run of privately owned timberlands in the white pine type yields amounting to three-quarters or more of those given for Site II in the yield table may be expected from the large areas of young growth which have followed forest fires or logging.

The final money yield of existing young white pine stands when they reach maturity is a matter for speculation only. The present stumpage value of white pine as indicated by sales in the past few years ranges from $6 to $12 a thousand. Cedar poles over 30 feet long are worth 2 to 3 cents a linear foot. White fir, hemlock, larch, and Douglas fir vary much, according to locality, from no value up to $2 a thousand. A general upward trend of stumpage prices may reasonably be expected in the future.

COSTS OF GROWING TIMBER

TAXES

The present tax laws of Idaho and Montana are not adapted to the growing of timber crops. According to figures compiled in 1923 for the Senate Committee on Reforestation by the Western Forestry and Conservation Association, cut-over lands in Idaho are more or less arbitrarily assessed at $1 to $5 an acre, and taxes range from 3 to 8 cents per acre. In Montana assessed values are $3 to $15, and taxes average 10 cents per acre.

The rate of taxation in Idaho on cut-over land would not be prohibitive to timber growing were there any assurance of a continuing rate. Under the present laws, however, as a young crop approached maturity it might be taxed each year at its full value, and the tax burden would become prohibitive. Hope rests in the general movement in the country for amendment of taxation methods to conform to the requirements of timber growing, and it seems a reasonable prediction that Idaho and Montana will fall in line with needed tax reform.

FIRE PROTECTION

The cost of fire protection was discussed in a previous section. For large forest tracts the annual cost of reasonably adequate protection may be assumed to be about 10 cents per acre, of which up to one-fourth may be borne by the Federal Government under the Clarke-McNary law. The cost will vary considerably according to circumstances. On wood-lot areas where a rancher resident on the land can give his tract incidental protection the cost may be very little.

SLASH DISPOSAL

Although slash disposal is an extremely important step in timber growing, it should not properly be considered a charge against the crop, but rather a logging cost incurred for the protection of adjoining lands, timber, and improvements. As previously stated, the cost of piling and burning will range from $0.60 to $1.25 for each thousand board feet of timber cut.

SILVICULTURAL MEASURES

Under Forest Service practice a volume of 1,500 to 3,000 board feet of white pine to the acre, with a value of $5 to $30, is usually left for seed trees or further growth. On a property managed for permanent production this may be considered a postponement of returns rather than a cost, since it may be assumed that trees left on the area will be harvested later, in some instances with additional volume accretion. For a private owner who is not committed to permanent forest management the recovery of this investment might be doubtful. The advisability of leaving white pine seed trees would, therefore, be influenced by the intentions and circumstances of each individual timber owner. Seed trees of other species do not involve an appreciable investment.

On the whole, it may be said that aside from slash disposal, which is a general fire protection rather than a timber-growing measure, the minimum steps necessary to leave white pine lands in a reasonably productive condition after cutting are practically without cost. The timberland owner who wishes to practice more intensive forestry, as is being done on the national forests, must, of course, incur greater expense. Considerable investment is required if the stand contains inferior species, which must be removed, or if there is an appreciable number of defective trees to be disposed of in order to favor white pine reproduction.

THE LARCH-DOUGLAS FIR TYPE

CHARACTER AND IMPORTANCE OF LARCH-FIR FORESTS

The characteristic species of the larch-Douglas fir type are western larch (*Larix occidentalis*) and Douglas fir (*Pseudotsuga taxifolia*). Practically all the other timber species of the region, western white pine, western yellow pine, Engelmann spruce, white fir, hemlock, and lodgepole pine, occur in mixture in various degrees, but the typical stand is nearly pure larch and Douglas fir.

The most important center of larch and fir production is in western Montana. Table 6 gives an estimate of the timber stands of the principal species in that region. In north Idaho the total stand of larch and fir is estimated at 14,448,000,000 feet, of which 6,563,000,000 is in private ownership, 1,687,000,000 in State, 5,953,000,000 in national forest, and 245,000,000 in other Federal ownership.

Over considerable areas mature stands average 10,000 to 20,000 board feet to the acre, but these do not represent the full yield possibilities of the type. The larch-fir type has suffered greatly from fire, and it is rare to find stands which have not been damaged and thinned out by ground fires.

TABLE 6.—*Timber stand in western Montana counties*[1] *by species*

[Millions of board feet—i. e., 000,000 omitted]

Class of ownership	Douglas fir and western larch	Western white pine	Western yellow pine	Other	Total
National forest	8,660	1,163	2,807	7,480	20,110
Other Federal	1,401	129	1,003	923	3,456
State	1,073	51	526	379	2,029
Private	6,477	139	4,312	969	11,897
Total	17,611	1,482	8,648	9,751	37,492

[1] Mineral, Granite, Ravalli, Flathead, Lake, Lincoln, Sanders, Missoula, and Powell Counties.

The rate of cutting in north Idaho has been covered in the discussion under the western white pine type. The 1923 lumber cut for the State of Montana was 426,739,000 board feet, of which 235,768,000 was larch and fir. Practically all of this came from the western Montana counties. Only about 60,000,000 feet was from national forests. The drain on the privately owned timber of western Montana was in the neighborhood of 360,000,000 feet. At this rate the privately owned timber of western Montana would last about 33 years, disregarding growth or loss from fire. As a matter of fact, however, more than half of the timber in this region is owned by three companies, and there are only two operating lumber companies in the State which now own enough timber to run more than 10 or 12 years at the rate of the 1923 cut. There is, however, a large amount of timber still held in comparatively small tracts presumably available for purchase, and these will be cut by existing mills. This situation has an important influence on the possibilities of timber growing by lumber companies in the State.

PRESENT LOGGING PRACTICE AND ITS RESULTS

The older cut-over lands in the larch-fir and yellow pine regions in both Montana and Idaho are in far better condition than the lands cut over during the past 10 or 12 years. Under the earlier practice the slash was left untouched, and while a considerable portion of the land burned over accidentally, a very large area escaped fire and now bears splendid stands of young growth. Logging was not so close in the earlier days as it is now, and in many stands in the larch-fir type much 12 to 14 inch material was left which will soon be ripe for a second cut. In the last 10 or 12 years under the compulsory slash-burning laws of Montana and Idaho slash has generally been burned broadcast after logging, the fire destroying all the young growth in the area and often spreading to older cuttings which had been left in good condition. In practice the slash-burning laws of both States have resulted disastrously to reforestation in the larch-fir and yellow pine types.

A single broadcast burn in the larch-fir type may or may not be followed by reproduction, depending on the severity of the burn and the survival of possible seed trees. As a general thing a great deal of young growth and trees under merchantable size are killed by broadcast burning. The dead trees subsequently make a veritable

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A TYPICAL LARCH-FIR FOREST

When the larger trees are cut an ample supply of those under merchantable size will reseed the area and, if protected from fire, will yield a second cut

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BROADCAST BURNING IN THE LARCH-FIR TYPE PRODUCES REPEATED BURNS

Broadcast burning of slash kills many of the trees remaining after cutting (A) and these as they fall increase greatly the danger of a second burn. A double burn in larch-fir forests is generally sufficient to remove all chance of natural reproduction of the forest for many years (B). Denudation of the forest is the almost inevitable result of broadcast burning

fire trap, so that future protection is almost impossible. It is true as a rule that fire breeds fire. The more a region is burned the more it will burn again. Green timber is always easier to protect than burned land.

Most of the logging done in the larch-fir region is horse logging; and, aside from their liability to damage by fire, cut-over areas are usually left in fair condition, with reproduction and trees under merchantable size generally present in sufficient quantity to form the basis of a second cut or to seed up the area.

BASIC FACTS BEARING ON TIMBER GROWING

The larch-fir type usually originates as an even-aged forest growing up from reproduction following fires. In many instances, however, subsequent fires have opened up the original even-aged stand and have in turn been followed by reproduction in the openings and under the thinned stand. This process may have been repeated several times, resulting in several distinct age classes in the same area—sometimes in groups, sometimes with the younger age classes forming an understory to the older classes. This two or three aged condition is very characteristic and occurs frequently.

Larch is much less tolerant of shade than Douglas fir, and there is a tendency for the percentage of fir to increase at the expense of the larch. Since larch is considered the more desirable tree, an effort should be made in marking trees to be cut on good sites to favor larch reproduction as much as possible.

Both larch and Douglas fir are reasonably windfirm. In uneven-aged stands windfall is not usually an important factor to be considered in marking. In even-aged stands of tall timber on moist soil there is considerable danger of windthrow of seed trees left from the cutting.

Douglas fir is a prolific seed producer and bears seed nearly every year. Larch bears some seed nearly every year, and good crops every five or six years. Larch seed is very light, 130,000 to the pound, and consequently is widely scattered by the wind.

Germination of both larch and Douglas fir seed is better on burned surfaces than on the natural forest floor.

Where the trees have good crowns both Douglas fir and larch increase in increment very considerably after release from a crowded stand.

Larch is frequently affected by a mistletoe, which causes large witches' brooms on the tree and eventually brings about defect and finally death of the tree. Trees having mistletoe should never be left as seed trees, and all mistletoe-infected trees of merchantable size should be cut.

MEASURES ESSENTIAL FOR GROWING TIMBER

FIRE CONTROL

Fire conditions are much less critical in the larch-fir region than in the white pine, and requirements for adequate protection are consequently simpler. The same arbitrary standard for area burned

over annually is used; namely, not more than 0.25 per cent of the protected area.

To assure this limitation, the following measures are proposed:

General protection.—(1) A four-hour control for green timber from July 1 to September 10.

(2) A one-hour control for cut-over areas from June 1 to September 30, with extension into May and October when occasion demands, for a period of 10 years after cutting.

(3) Areas of special danger, such as blow-downs and undisposed slashings, to receive such special patrol and equipment as the officer responsible for their protection shall deem necessary.

Control organization.—(1) There must be some agency responsible for getting immediate action on every fire and for seeing that each is confined to the smallest possible area and that no fire is left unattended before it is out.

(2) The responsible agency must be permanent and dependable.

(3) Costs of protection should be equitably distributed among owners.

(4) There should be some responsible officer prepared to take suitable action upon every infringement of fire law or legal regulation concerning fire prevention.

(5) Damage and cost of fighting man-caused fires, especially those resulting from negligence, should be assessed to the person or agency responsible.

(6) Education in fire prevention must be systematically undertaken.

The greater part of the larch-fir forests of northwestern Montana are receiving reasonably adequate protection at the hands of the Federal Government, the State, or cooperative associations. For this, the Forest Service, with the greatest acreage to protect, expends on an average 5.5 cents per year. The State and the Northern Pacific Railway Co. pay for intermingled lands at the same rate. The State, likewise, maintains a separate organization in a number of localities and expects to give adequate protection at comparable rates.

The cost to private owners of protection on intermingled and adjacent land ranges from nothing for a few of the owners to 2.2 cents per year for association contributors. These favorable rates for a large part of these private lands have been possible because the owners have taken advantage of improvements, lookouts, equipment, supervisory organizations, and in some cases the patrol maintained by the Federal Government for the protection of the national forests. Greater accessibility also favors much of the private land.

The problem of adequate protection in this region is in a large measure a financial one. It is a problem of distributing the cost equitably among all owners. Of course, new improvements and betterments in organization and practice are still desirable and will be possible when finances are provided.

Improvements in private protection should take the direction of additional patrol in the spring and fall, more painstaking efforts to prevent spread of fire on cut-over areas, and better law enforcement.

The permanent protection resulting from a compulsory patrol law is a thing to be desired.

State participation in and supervision of protective effort is essential.

SLASH DISPOSAL

Larch-fir slash, while not as great a fire danger as white pine or cedar slash, is, nevertheless, difficult to protect from fire, and a fire once started in it is very hard to control. Inflammability varies with the amount of Douglas fir, white fir, or spruce in the stand. The slash from a nearly pure larch stand is not a serious fire danger.

BROADCAST BURNING

Uncontrolled burning of slash in the larch-fir type is an indefensible measure. It not only often destroys large amounts of promising reproduction and young timber but is an inadequate fire-prevention measure, since it leaves the burned area in condition to burn again almost as readily as the original slash. In general, no slash disposal at all is preferable to broadcast burning. There are many large areas of old cuttings in Montana in the neighborhood of Eureka, Kalispell, and St. Regis which have never burned and which are now, after a lapse of 15 to 20 years, comparatively safe from fire and well stocked with second growth. Burned areas are a continual menace, and many of them get worse each year rather than better.

PILING AND BURNING

The standard practice in effect on national forest cuttings in the larch-fir type is piling and burning of all slash except in very light cuttings of pure larch away from roads and other travel routes, where the limbs may be merely lopped and left on the ground. Under all other circumstances piling and burning is the rule.

A large quantity of young growth is often present in larch-fir stands, and brush piles must therefore be located in openings or on skid roads and away from live trees. Further, they must be burned carefully at a time when fire will not run.

Cost.—The cost of piling and burning varies, increasing with any increase of Douglas fir, white fir, or spruce in the stand. The usual cost is from 60 to 90 cents a thousand feet; 75 cents would probably be a fair average for most conditions.

These costs are based on piling and burning after the operation of logging is completed. It is believed that a considerable reduction can be made by carefully studying the operation and coordinating disposal with swamping. In cutting roads or rights of way for chutes during the period when it is safe to burn, slash can often be piled in the middle of the road and burned at the time instead of being piled at the sides of the road to be rehandled later. There are also possibilities in progressive burning of slash by the swampers before skidding.

Partial slash piling.—The primary object of slash disposal is reduction of inflammability. Piling and burning all the slash accomplishes this as far as it can reasonably be done. A lesser measure than complete piling and burning will still greatly reduce the inflammability and afford at least a reasonable assurance that the area can be protected. Such modified measures consist of piling and burning a portion of the slash and leaving the rest of it as it lies. The places on which the slash is to be piled and burned would have to be planned

for each area so as to give greatest protection for the amount of money expended.

In general, partial piling and burning should be guided by two purposes: (1) Reduction of the probability of fire starting through human agency on those parts of the area most likely to be traveled; (2) the establishment of lines which would assist in controlling a fire which might get started.

The first purpose would be accomplished by piling and burning a strip 100 feet wide on each side of traveled roads, trails, railroads, and main chutes. The second purpose would call for additional strips piled and burned to cut the area into sections. These strips should follow chutes and skid roads when possible. In general, about 20 per cent of the slash should be piled and burned. On this basis the cost would be reduced to about 15 to 20 cents per thousand on the entire cut. At the same time, cut-over areas left in such condition will not return to normal inflammability in less than 10 to 15 years and should receive especially intensive patrol during that period. The cost of this patrol will vary from 3 to 5 cents an acre per year, depending mainly upon the size of the tract.

METHODS OF CUTTING

The larch-fir type is one of the easiest of forest types to handle by simple, inexpensive methods. Most lumber companies are cutting down to a 14-inch diameter (breast-high), and this nearly always leaves a sufficient number of suitable trees to reseed the area. Frequently there is already a good stand of seedlings on the ground or sometimes a sufficient number of 8 to 14 inch trees to form the basis of a second cut. As a result of these conditions proper slash disposal and subsequent protection from fire are all that is required to leave most cut-over lands in a reasonably productive condition.

There are, however, additional measures which will improve the other and varying conditions left after ordinary logging and will result in an increased future yield.

CUTTING TO OBTAIN FULL FOREST CROPS

Approximately 80 to 90 per cent of the merchantable stands in the larch-fir type are uneven aged. The range of conditions which may occur in uneven-aged stands is so wide that only very general directions for marking trees to be cut can be given, and a high degree of judgment must be used by the marker to adapt his marking to the stand.

In general the object in uneven-aged stands will be to remove by a selection cutting the larger, mature trees and leave the younger growth as the basis of the next cut. The simplest stand to handle is veteran larch with reproduction 20 or 30 years old as an understory. In such stands, if the reproduction is complete, all the mature trees should be cut. If there are breaks in the reproduction, seed trees should be left.

Various more complex combinations of age classes may be encountered. Under such circumstances the larger trees should be cut to a diameter of 14 to 20 inches, leaving seed trees wherever the stand of younger trees or reproduction does not fully occupy the ground.

The percentage of merchantable stand to be left will vary widely according to conditions, but will usually be between 10 and 30 per cent.

Groups of trees between 12 and 16 inches in diameter should be thinned. This is a phase of the marking calling for skill and judgment in selecting the best and most promising trees to leave and maintaining proper spacing for the best growth. Larch should be given preference over Douglas fir, and particular attention should be given to removal of badly fire-scarred or diseased trees.

Yellow pine in mixture should be encouraged. Trees of the "bull pine" type and thrifty mature trees capable of putting on good growth should usually be left.

It is desirable to encourage white pine where it occurs on the moister situations. Occasional scattering white pine trees should nearly always be left for seed trees unless distinctly overmature.

White fir, balsam, and lodgepole pine should not be encouraged and should be cut to the lowest merchantable limit.

Even-aged mature stands with no reproduction present are sometimes encountered. To obtain reproduction after cutting, a stand of this class should be cut clean except for three to six seed trees to the acre. Seed trees, preferably of larch, should be thrifty, full-crowned trees of the dominant or codominant class, selected for their seed-bearing qualities and probable windfirmness.

PRACTICABILITY OF TIMBER GROWING IN THE LARCH-FIR TYPE

From the standpoint of value of product and rate of growth the larch-fir type does not offer as high returns as do some of the other forest types. The value of larch and fir lumber is comparatively low and may always remain considerably under such species as white pine and yellow pine. The rate of growth is considerably less than in the white pine type or the coast fir region.

On the other hand, the larch-fir has some advantages which other types do not possess. The general uneven-aged character of much of the larch-fir timber makes it possible to leave standing enough timber to serve as the basis for a second cut in 20 to 40 years. It is not necessary to wait for a full rotation to get returns. Furthermore, the cost of leaving the stand in productive condition after logging is comparatively small, and the cost of fire protection in the larch-fir region in Montana is very considerably less than in the white pine region in Idaho.

Conditions will vary according to the character of stands, but whenever a thrifty stand of 10 to 14 inch timber is left after logging, as is often the case, it would appear to be a promising speculation to hold the area for a second cut, which may be expected in 20 to 40 years.

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